



Mar 31, 2021

Dr. Steven Cliff, Acting Administrator
U.S. Department of Transportation
1200 New Jersey Avenue SE
West Building Ground Floor, Room W12-140
Washington, DC 20590-0001

Re: Advance Notice of Proposed Rulemaking on a Framework for Automated Driving System Safety, Docket No. NHTSA-2020-0106

Dear Acting Administrator Cliff,

Motional thanks NHTSA for the opportunity to provide comments in response to the agency's advance notice of proposed rulemaking ("ANPRM") on a framework for Automated Driving System ("ADS"). We agree and support the comments submitted by Self-Driving Coalition for Safer Streets, of which Motional is a member. In addition, Motional's comments below provide answers to individual questions where our perspective as an Autonomous vehicle ("AV") developer may be valuable.

Self-driving technology promises to deliver vast benefits to humanity: increased mobility, more free time, and—most importantly—safer roads and fewer accidents. To achieve that promise, our comments are consistent with the idea that a future federal ADS safety framework needs to accomplish three things:

1. It must enhance public trust in AV safety. NHTSA can do this by ensuring that the research informing the framework and future federal regulation is transparent.
2. It should maximize AV deployment. Regulations that are too rigid or premature will put the safety benefits further out of reach.
3. It must protect Innovation. Issuing guidance is consistent with the government's approach to date, which has effectively encouraged a tremendous investment in AVs' safe development.

Background on Motional

At Motional, we're making self-driving cars a safe, reliable, and accessible reality. We're developing this technology for all people—for families, for commuters, for elderly passengers who need better access to mobility, and for urbanites who want to choose



how they move through their cities. We prioritize the safety and security of passengers and the public at every step.

Our safety track record stands out. Our vehicle design, development, and testing efforts ensure we're as safe as or safer than human drivers. Our focus on safety has real-world impact, and we're proud to report that we've driven over one million autonomous miles, in challenging city environments around the globe.

Our team is responsible for some of the industry's largest leaps forward, including the first fully-autonomous cross-country drive in the US, the launch of the world's first robotaxi pilot, and operation of the world's most-established public robotaxi fleet. That fleet has provided over 100,000 rides, with 98% of riders awarding their ride a five-star rating. After a rigorous review by an external safety assessor, we also became one of the few companies conducting fully driverless testing. But our public partnership is only one dimension of our fundamental commitment to safety.

We believe that industry collaboration is critical. We co-published "Safety First for Automated Driving," recently released as an official Technical Report of the International Organization for Standardization, as the most comprehensive report to date on how to build, test, and operate self-driving vehicles safely. We followed that publication with our Voluntary Safety Self-Assessment, which continued our emphasis on the safety, verification, and validation of self-driving vehicles.

We believe that safety transcends competition. That's why, in 2019, we launched nuScenes, a first and largest-of-its-kind dataset of challenging scenarios for driverless vehicles to navigate in order to safely engage with their ever-changing road environments. It's also why we made that data freely and publicly available to the research and academic communities, and why we significantly expanded that dataset in September 2020. We're proud of the safety-driven culture of data-sharing that nuScenes catalyzed, with more than ten similar datasets now available from other major industry players. Our relentless focus on safety is why people trust us and governments partner with us. We'll keep working hard to maintain that trust.

Headquartered in Boston, Motional has operations in the US and Asia. We are a joint venture between Hyundai Motor Group, one of the world's largest vehicle manufacturers, and Aptiv, a global technology leader in advanced safety, electrification, and vehicle connectivity.

Question 1: Describe your conception of a Federal safety framework for ADS that encompasses the process and engineering measures described in this notice and explain your rationale for its design

Motional strongly supports development by NHTSA of a federal safety framework for ADS, to enable the safe deployment of autonomous vehicles (AVs). At the current stage of technology development – early in the product evolution cycle and involving frequent iterations and improvements – the most appropriate approach for NHTSA is to issue guidance to AV developers after giving due consideration to all stakeholders’ inputs. NHTSA guidance will provide helpful direction to AV developers on best practices for their safety case, while at the same time being sufficiently flexible to support desired innovation by developers.

Process measures. NHTSA’s ADS safety framework guidance should focus in the first instance on process measures. There is growing agreement among AV industry stakeholders that process-based measures such as ISO 26262, ISO 21448, IEEE TS17961 and UL 4600 can be used by AV developers to support a safety case. Indeed, Motional and ten other automotive technology companies have developed an approach based on these measures for the safe design and testing of AVs, published in a whitepaper entitled “Safety First for Automated Driving (SAFAD)” (2019). The SAFAD collaboration highlights Motional’s core belief that stakeholders should collaborate to achieve road safety collectively, through the efforts of AV developers, regulators, infrastructure providers, and other interested parties.

During the time that NHTSA is developing guidance on process measures, Motional supports NHTSA having visibility into how AV developers use and apply process measures to build their safety case (subject to appropriate protection of developers’ confidential business information). Motional also believes that NHTSA’s bid to support rapid development of AVs in the US requires a harmonization of US regulations with regulations being promulgated around the world to reduce compliance burdens on AV developers and make outcomes more transparent to the public.

Engineering measures. Additional dialog is needed between NHTSA and stakeholders on the subject of potential engineering measures. Motional has been testing AVs across its several sites in accordance with the safety principles outlined in our most recent VSSA. However, in the absence of any emergent industrywide standard around the core functions of ADS safety performance, it would be premature to mandate that AVs meet engineering performance measures prior to a full discussion of what these measures might be and how they would be implemented and applied. As indicated in

the ANPRM, any hastily issued regulations around such engineering measures could negatively impact AV developers' ability to innovate at this relatively early evolutionary phase of overall AV development.

Question 2. In consideration of optimum use of NHTSA's resources, on which aspects of a manufacturer's comprehensive demonstration of the safety of its ADS should the Agency place a priority and focus its monitoring and safety oversight efforts and why?

Process measures. NHTSA should prioritize and focus on providing holistic guidance for utilizing process measures, including those identified above (ISO 26262, ISO 21448, IEEE TS17961 and UL 4600) and any others that are under development (such as IEEE P2846) or developed in the future, to support a safety case. Among other things, NHTSA should establish and maintain a digital repository for available guidance, best practices, and technical standards. NHTSA should develop non-binding guidance on the application and utilization of these process measures by AV developers, particularly in the context of conducting driverless operations in various (and varying) ODDs. This guidance should be technology-neutral and provide developers the flexibility to innovate in identifying how to deploy driverless fleets.

In addition, NHTSA should provide guidance to AV developers whose programs are reviewed by an external assessor. NHTSA should encourage companies to give assessors access to their proprietary systems, technology, and operations, and provide guidance for how to do so securely.

Engineering measures. Over a longer time period, and based on dialogue with AV developers and other stakeholders, NHTSA should evaluate the possibility of providing non-binding guidance on developing simulation scenarios that can be used by all AV developers, and on potential minimum performance standards for AVs.

Question 3. How would your conception of such a framework ensure that manufacturers assess and assure each core element of safety effectively?

Prioritizing and focusing on the process measures identified above will help ensure that AV developers and manufacturers assess and assure each core element of safety, because these measures are wide-ranging and entail consideration of all such core elements. Rather than assessing each core element individually, safety assurance

should be based on the entire AV program and not on a particular subsystem's performance in isolation. This conception places overall safety as the ultimate goal, while supporting innovation by individual AV developers as to particular core elements. Such innovation may in appropriate circumstances become industry best practice and positively impact many developers' safety cases.

Question 4. How would your framework assist NHTSA in engaging with ADS development in a manner that helps address safety but without unnecessarily hampering innovation?

NHTSA has to date prudently removed barriers to development without reducing expectations of safety. Our paradigm is consistent with that approach and is designed to enable AV developers to continue to possess the flexibility necessary to innovate on new technologies while prioritizing safety. NHTSA would play an active role with AV developers and other stakeholders in identifying, distilling, and disseminating safety best practices, through direct stakeholder engagement.

NHTSA should exercise extreme caution before taking any steps that could rigidly fix safety argumentation methods or specific aspects of system architectures. Such measures risk the unintended result of impeding technological progress and thereby delaying introduction of the safety improvements (and reductions in serious injuries and deaths) widely anticipated from AVs.

Question 6. Do you agree or disagree with the core elements (i.e., “sensing,” “perception,” “planning” and “control”) described in this notice? Please explain why.

Motional agrees that the core elements of sensing, perception, planning, and control are fundamental to AVs' safe operation today. Additionally, we encourage NHTSA to also consider the interrelationship of these elements and how they function as an integrated whole. The manner in which these elements are related can vary from developer to developer, and the performance of a system or subsystem addressing one element may depend in considerable part on those addressing other elements.

Question 11. What rule-based and statistical methodologies are best suited for assessing the extent to which an ADS meets the core functions of ADS safety

performance? Please explain the basis for your answers. Rule-based assessment involves the definition of a comprehensive set of rules that define precisely what it means to function safely, and which vehicles can be empirically tested against. Statistical approaches track the performance of vehicles over millions of miles of real-world operation and calculate their probability of safe operation as an extrapolation of their observed frequency of safety violations. If there are other types of methodologies that would be suitable, please identify and discuss them. Please explain the basis for your answers.

Rule-based Methodologies

Motional supports an industrywide move towards rule-based methodologies for evaluation of ADS safety performance. Motional's research, much of which has been peer-reviewed and available to the public, indicates that rules-based methodologies, such as Motional's Rulebooks, can be an effective tool in analyzing ADS operation.^{1 2 3} These methodologies benefit from being able to pinpoint both the rules violated as well as the degree of violation, providing a clear picture of where one or more core functions of the ADS safety performance need improvement. NHTSA can promote further research into rule-based methodologies by promoting collaboration among AV developers and stakeholders on the development and harmonization of methodologies and approaches for encoding traffic laws as rules, particularly where laws conflict or are in tension with one another. While NHTSA should provide guidance on what constitutes good AV behavior in certain complex scenarios in order to inform the formulation and structuring of corresponding rules in a rule-based framework⁴, the agency should refrain from prematurely adopting a set of rules or rule hierarchy or placing constraints on how industry adopts rules or rule hierarchies. Any regulations from NHTSA at this nascent stage of the AV industry that forces adoption of a standardized set of rules that all ADS must obey risks ossifying further development by over-constraining ADS operations – particularly in complex driving environments.

Statistical Methodologies

Motional discourages NHTSA from promoting the exclusive use of statistical methodologies to make general safety claims. Motional agrees that there is undeniable value in testing its ADS in the real world. However, research indicates that traditional,

¹ See Collin et al., Safety of the Intended Driving Behavior Using Rulebooks, IEEE Intelligent Vehicles Symposium (IV) (2020), pp. 136–143.

² See Xiao et al., Rule-based Optimal Control for Autonomous Driving, Arxiv:2101.05709 (2021)

³ Bin-Nun, et al. *Heinrich's Triangle Heavy-Tailed Distributions and Autonomous Vehicle Safety*. Transportation Research Board Annual Meeting (2020).

⁴ See De Freitas et al., From driverless dilemmas to more practical commonsense tests for automated vehicles, Perspective (Jan. 17, 2021).

crash-based statistical methodologies require AV developers to test the core ADS safety functions of their AVs over hundreds of millions to billions of real-world miles to demonstrate their reliability in terms of fatalities and injuries.⁵ Additionally, adopting statistical methodologies reliant on logging real-world miles could create perverse incentives for AV developers and encourage careful curation of testing activities to log “easy miles” further reducing the efficacy of such methodologies. Motional believes that traditional and emerging statistical methodologies for safety assessment can find use in assessing simulation-driven miles alongside real-world miles. Simulation-driven miles can indicate whether an ADS will operate reliably in a simulated ODD or when confronted with certain well-defined scenarios. NHTSA should encourage additional research and development in this area by both AV developers and the broader research ecosystem.

Question 14: What additional research would best support the creation of a safety framework? In what sequence should the additional research be conducted and why? What tools are necessary to perform such research?

An area of research that would be valuable for NHTSA to undertake immediately would be advancing methodologies to formally define safe driving behavior. When assessing AV performance, there is a lack of data or consensus for describing safe driving behavior in various scenarios. Among the questions that merit this examination are: (i) what actions do average drivers engage in, compared to the safest drivers; and (ii) how should AVs be expected to behave to further increase safety? Supporting research that benchmarks these behaviors in a format that can be used by AVs will support AV development and promote public confidence.

Other areas of research that NHTSA should conduct or promote in the near term to support the creation of a safety framework include:

- Evaluation of the effectiveness of rule-based approaches to create safer outcomes. There is a spectrum of possible actions on the road, and the outcomes should be scored as such (De Freitas et al.).
- Research into how to translate qualitative rules of the road into deterministic parameters that can be understood by an AV. This research can be leveraged

⁵ See Kalra and Paddock, Driving to safety: How many miles of driving would it take to demonstrate autonomous vehicle reliability?, Transportation Research Part A: Policy and Practice, 94 (2016),

by state and local governments, as well as AV developers, to enable AVs to operate consistently with the intended purpose of non-quantitative traffic laws.

In the longer term, NHTSA should engage with industry and academia to develop a foundation on which future engineering measures can be crafted. Before NHTSA and stakeholders can decide on what “right answers” (de Freitas et al.) for engineering measures, designing the tests themselves involve complex social and regulatory inputs that the near-term research will help address. If the engineering measures for AVs are aligned with social expectations, AVs that meet or surpass those standards can be expected to have wider public acceptance, leading to smoother and safer deployments of AVs.

We appreciate the opportunity to submit these comments and look forward to engaging further with the agency’s rulemaking process.

Sincerely,

/s/ Sam Wempe
Director of Government Relations and Public Policy